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the Proceedings contains an interesting essay on 'Some higher aspects of mesmerism,' by Messrs. F. W. H. Myers and Edmund Gurney, who treat of the existence, limits, and varieties of mesmerism as a therapeutical agency; and a further report on 'Thought-transference,' with numerous statistics and diagrams, by Malcolm Guthrie, J.P. While many of Mr. Guthrie's experiments are novel, and as a rule more difficult than usual, yet they are of the same general character as those with which those who have followed the progress of the societies for psychical research, both in England and in this country, are already familiar.

NICHOLAS MURRAY BUTLER.

GIANTS AND DWARFS.

THE above title is prefixed to a series of articles¹ recently published, but is, however, somewhat misleading. What is attempted is, not the consideration of the causes and consequences of abnormal deviations in height in the human species, but a presentation of the differences resulting from the absolute size of an animal, — a sort of 'animal mechanics,' which, in the author's opinion, is to become an important chapter of morphological science. The speculations presented are not without some value and considerable ingenuity: but they are characterized by a passion for reducing every thing to mechanical terms in a way which does not fit biological facts; by a peculiar anthropomorphic point of view, which gauges the actions of animals as though the animals were men; and by an avoidance of evolutionary principles, which one would think would be especially important in this connection. Perhaps it will not be altogether without interest to sketch very briefly the author's methods and his conclusions.

If a body is ten times smaller in one dimension, say in height, than another, and is to retain the same shape as the first, all linear dimensions will be reduced to 1-10, all surface dimensions to 1-100, and all solid dimensions to 1-1000, of their size in the original body. For brevity's sake, we will call an animal of average size a meso-animal (*Me*); an animal 1-10 as large will be a micro-animal (*Mi*); one 10 times as large, a macro-animal (*Ma*). Keeping these statements in mind, we will review the differences which would be caused in the several vital systems by a reduction of an animal to 1-10 its size.

Beginning with the skeleton. We will measure the strength of a bone by the multiple of the weight of the animal necessary to crush it. Now, as the strength of a beam (the bone) varies (1) as

the square of the thickness, (2) directly as the breadth, (3) inversely with the length, if the bone is reduced 1-10 in length, breadth, and thickness, it can carry 1-100 of its former weight, while it has been reduced 1-1000 in volume; i.e., it is relatively 10 times stronger than the large bone. If the tooth of a meso-dog can just bear the dog's weight, then the tooth of a micro-dog can carry 10 micro-dogs; or, if it is to carry its own weight, it can become 1-5 smaller in cross-section. The smaller an animal, the more tender, weak, and soft may its skeleton be to satisfy its needs. This principle accounts for the presence of teeth in micro-animals of such a shape as would be useless in meso-animals.

Next the muscles. If 1,000 micro-animals were to jump against one meso-animal, each *Mi* would jump as high as the *Me*; for relatively equal muscles, with a single contraction, do relatively equal work. But altogether they will do absolutely as much work as the *Me*. The jump will depend on the ratio of the muscular system available for jumping-purposes to the whole body. A thousand small muscles will lift 10 times as much as one muscle 1,000 times its weight. Moreover, the small muscles would contract quicker than the large one. If one meso-man can throw stones the size of his fist for a distance of 50 of his own steps in 1 second, then a micro-man could throw stones the size of his fist for a distance of 500 of his own steps in 1-10 of a second. A micro-girl would knit a stocking of an equal number of meshes in 1-10 the time required by a meso-girl.

Again, take walking. The vibration of the leg of the micro-man will take about $\frac{1}{10} \left(\frac{1}{\sqrt{10}} \right)$ of the vibration-time of the leg of the meso-man. The small man will walk very rapidly; but, as fatigue depends on the number of contractions, he will tire easily, will be out of breath soon, and will have covered very little distance. If we reduced our man by 1-100, the walking would be so rapid as to give forth a low tone; and if to 1-1000, the vibration of his legs would give a shrill note. Hand-shaking would take the form of a gentle chirp. The micro-man is evidently at a great disadvantage in walking: this can only be remedied by giving him different locomotive organs and a different mode of locomotion. If we give him very long extra legs on each side, and put his body between them, he will be able to overcome the inertia of his body much more readily; he will be able to resist small shocks without shifting to a great extent the centre of gravity; and he will acquire a hopping gait, which is much better suited to small animals. In short, he will approximate the arthropod, in

¹ K. Fuchs, *Kosmos*, 1885, ii., Nos. 3, 4, 5.

particular the insect type. This proposition that the arthropod form is best adapted for small animals, and the mammalian form for large ones, is one of the points insisted upon throughout.

Amongst other differences are the following: The nervous impulses would be conducted to the centre in 1-10 the time, and his reflex movements and reactions would be quicker. A water-rat can see the blaze of a gun and dip under the water before the shot has time to reach it. With regard to warmth, it is shown that the body surface of a small animal gives off more heat proportionately than that of a large one: hence small birds have a thick covering, or, again, the small animals become cold-blooded.

But we will leave this part of the subject to consider what may be called a micro-psychology. Some rather curious conclusions are drawn with regard to the sense of sight. While the same amount of light will affect the retina of the meso- and the micro-man, nevertheless, owing to the difference in convergence of the two eyes (upon which depends the inference of distance), the micro-man will judge things to be smaller and nearer than the meso-man. His horizon would be much more limited, and in seeking an object he would be less apt to find it.

As to hearing. As micro-animals live in a condition where a constant noise is present, they acquire special organs for making loud noises, such as are found on the legs of some insects; while, of course, their hearing is less available to them than in the case of larger animals.

The general principle with regard to the nervous system is this: as the amount of nervous matter necessary to the needs of a small animal is proportionately much smaller than in a larger animal, such nervous matter becomes available for other purposes, and thus very fine sensibility to small physical variations, and the development of peculiar sense-organs, become possible. Eyes and ears are multiplied, touch-organs of various kinds become numerous, and there is more room for variability than in higher animals.

This theory makes it probable that small animals are endowed with a sensibility for fine discriminations of temperature, barometric pressure, moisture, and so forth, which is unknown to us; and thus we account for the observation that animals take cognizance of the approach of a storm before man does.

With regard to psychic life, the following statements will be of importance: the micro-animal procures its food for a given period with less trouble than a meso-animal, it builds its house in a much shorter time, it foresees natural changes

much better, and its movements are quicker. The result will be far-reaching forethought by means of house-building and harvesting instincts. Any act desirable for the moment, the meso-animal will be apt to neglect on account of the bother of doing it. A man sees a spot on his writing-desk for years, and never cleans it up; he decides to learn by heart a table of constants which has to be looked up with trouble each time, but never does it. This dread of labor causes most kinds of neglect. But with the micro-animal the act follows the word; there is no trouble, and thus much annoyance and danger to health are avoided. In the case of approaching danger, say of a storm, a meso- and a micro-animal will act very differently. The meso-animal recognizes the danger only when it is near, is flurried and frightened, has no time to build a shelter, and must seek a chance one. The micro-animal knows that the danger is not very near, that he has ample time to build a shelter, and need not trust to chance. And thus we see why many of the smaller animals prefer to build a new nest, to protecting or finding an old one, it is so readily done. By arguments which it would be difficult to reproduce, the conclusion is reached that the train of thought of this micro-animal is related to that of the meso-animal somewhat as a minuet to an opera of Wagner's, or a frieze pattern to a painting by Kaulbach; also that his conceptions would tend to be mathematical and regular. But in general it may be said that in psychic life the meso-man would have the advantage of the micro-man.

This very partial account of these speculations will, perhaps, serve to show their general tendency. They certainly belong to a class of thinking which is rather foreign to recent thought, but bring with them a suggestiveness which makes the problem discussed a very interesting one. The most serious objection is that very little attempt is made to show that the theory fits the facts (which might easily have been done), and more attention is paid to select facts that seem to fit the theory. As particularly worthy of consideration, may be noted the argument that when proportionately less of a certain tissue is needed for actual sustenance of the animal, more of it becomes disposable, and is subject to variation. It would seem possible that some valuable facts might be attained by a careful experimental study of the problems suggested by these theoretical considerations; and while they will not be sufficient, as they have been to our author, to rear upon them a whole physiology, a whole zoölogy, and a whole psychology, they will do a unique service to science.